INVESTIGATING THE NATURE OF FRICTION

As we have discussed in previous classes, friction is:

- ☐ a force that resists motion
- ☐ a force that always acts in a direction opposite to the motion (or intended motion) of an object.

Friction is a force that often is not beneficial but may, at times, be beneficial. For example, friction in an automobile engine is not desired yet the friction between the tires and the road surface is what keeps the car from skidding when making a turn and is thus desired.

There are two types of friction that we will deal with in this course – *static friction* and *kinetic friction.*

FBD Corner

Static friction is the type of friction that prevents objects from moving. It has a range of values for any object/surface. Consider an object at rest on a horizontal surface. Draw an FBD of this situation. You should observe that there are only two forces acting on the object – F_N and F_g. According to Newton's Laws of motion, these two forces are equal in magnitude and thus result in an $F_{NET} = 0$ N.

Now envision yourself applying a light horizontal push on the object to the right such that the object does not yet move. Draw an FBD for this situation. You should have the same forces as before PLUS your applied force. However, under this situation, the forces are unbalanced and the object should accelerate (Newton's 2nd Law). However, the condition is that the object does not move! Thus there must now be a force acting against your applied force – *the force of static friction.*

Now envision yourself applying an even greater horizontal push on the object to the right such that the object does not yet move. Draw an FBD for this situation. You should have something similar to the previous FBD. What is different? The applied force is greater in magnitude and, as the object does not yet move, must be equal to the *force of static friction.* In this scenario, the force of static friction has increased. As stated above, *static friction has a range of values…*

Eventually, you will apply enough force to get the object to 'slip' and to start moving. You have reached the maximum possible force of static friction for the mass/surface.

Once the object starts to slide, you will realize that it takes less force to keep the object moving at a constant velocity. Draw a FBD for the object in this situation. You will soon realize that $F_{NET} = 0$ N and that the force of friction is less than the maximum force of static friction. The force of friction present while objects are moving is known as *kinetic friction*. Unlike static friction, it has only one value for any object/surface.

Static and kinetic friction involves two objects that are in contact with each other. The friction is dependent on:

- the irregularities or interlocking nature of the two surfaces that are in contact with one another
- the electrostatic forces of attraction between the atoms of the two surfaces

When writing up the theoretical portion of your laboratory report, be sure to discuss the above two items in greater detail as they pertain to the two types of friction *(ie. do research!)*

MATERIALS:	*wooden block with a hook on the end*	*Newton force scale (0-20 N)*
	several masses	*Several different surfaces*
	a shoe	

PROCEDURE:

1. Place the block of wood on the lab bench and a mass of 200 g or greater on the block of wood, taking care to position the masses nearest the end with the hook. Record the mass of the *system*.

2. Attach the force scale to the hook and pull on the force scale such that the scale is parallel to the desk surface. Continue to slowly increase the force until the block of wood slips – take note of the maximum force reached. Repeat five more times over the same area and determine the average *static friction noted for the system*.

3. Once the wooden block slips, continue pulling on the system with a *constant horizontal velocity*. Record the force with which your are pulling. This force is the *kinetic friction for the system*. Repeat this several times and record the average kinetic friction for the system.

4. Repeat the above steps 4 more times, each time using a different combination of masses on the block. Record your findings.

5. We know that some surfaces are rougher than others. Repeat the above steps on two different surfaces.

6. Determine if surface area affects the static and kinetic friction for the block of wood. To do so, place the block of wood on its side (or upside down, depending on the block given you). Ask your teacher for details. Carry out the above steps and see if there is any difference.

ANALYSIS OF YOUR DATA:

I. For the first part of the investigation (steps 1-4), what impact did the mass have on the friction experienced? Using the masses of the system, determine the normal forces (F_N) experienced and plot a graph of $F_{STATIC\ FRICTION}$ vs F_N, and repeat for $F_{KINETIC\ FRICTION}$ vs F_N. From the results, derive the resulting mathematical equation for each of the two types of forces. Research the term *coefficient of static friction* and *coefficient of kinetic friction* and indicate how these two terms relate to the investigation at hand.

II. You conducted the same type of investigation using different surfaces. Does the relationship between the $F_{STATIC\ FRICTION}$ and F_N change? $F_{KINETIC\ FRICTION}$ and F_N ? Do the coefficients remain the same? Support your answers to these questions by drawing the reader's attention to the pertinent parts of the investigation.

III. How does changing the surface area affect the outcome? Comment on your findings and offer an explanation.

IV. Design and conduct an investigation which would enable you to determine coefficient of static and kinetic friction for your shoe. Share your findings and identify who has the stickiest shoes in class!

SUBMIT YOUR FULL FORMAL LAB REPORT IN ONE WEEK'S TIME

One report may be submitted per pair of students